Calibration of and Preliminary Results for a NUMI Beam Coincident Neutron Detector in the MINOS Tunnel

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Overview

- Introduction
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  - My Detector
- Calibration
  - Energy Calibration
  - Separation Algorithm
- Data Acquisition
- Results
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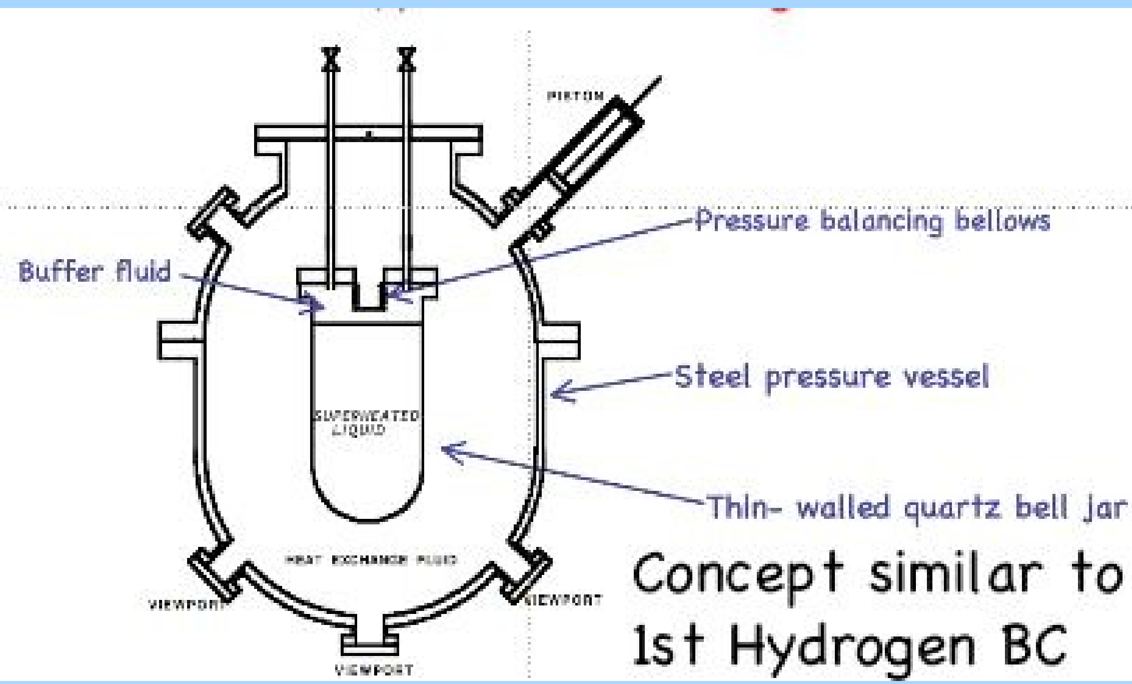
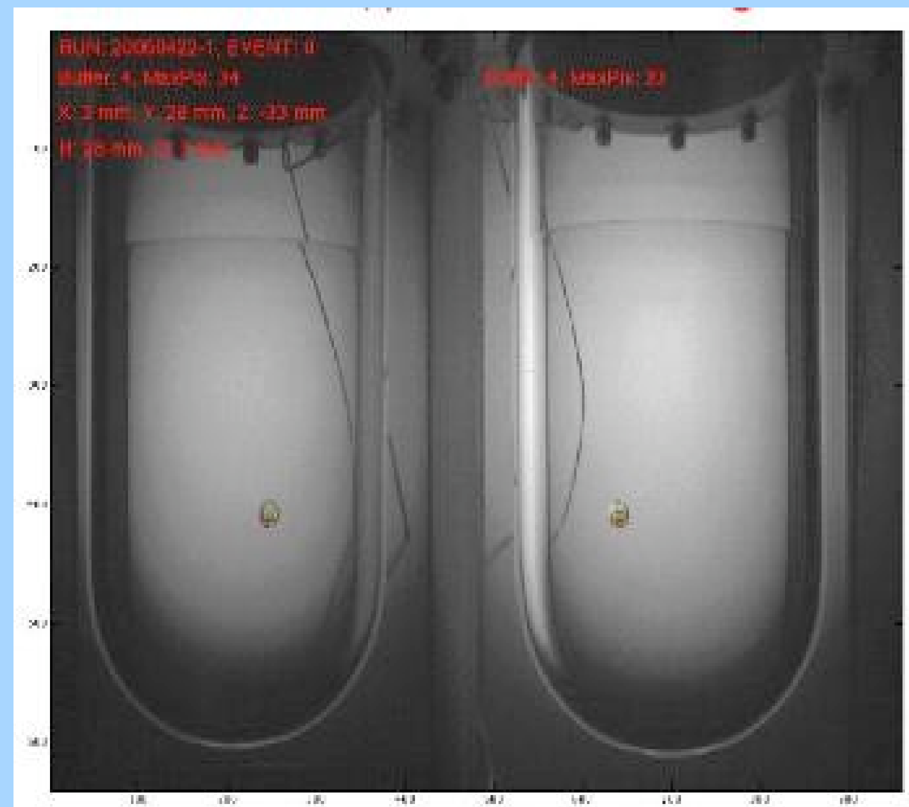
COUPP

Who?	Fermilab, University of Chicago, Indiana University South Bend
What?	A bubble chamber dark matter detector
Where?	Currently in the MINOS tunnel, but in the future, SOUDAN
Why?	Excellent intrinsic gamma rejection
	Good sensitivity to both SD and SI interactions
	Low cost



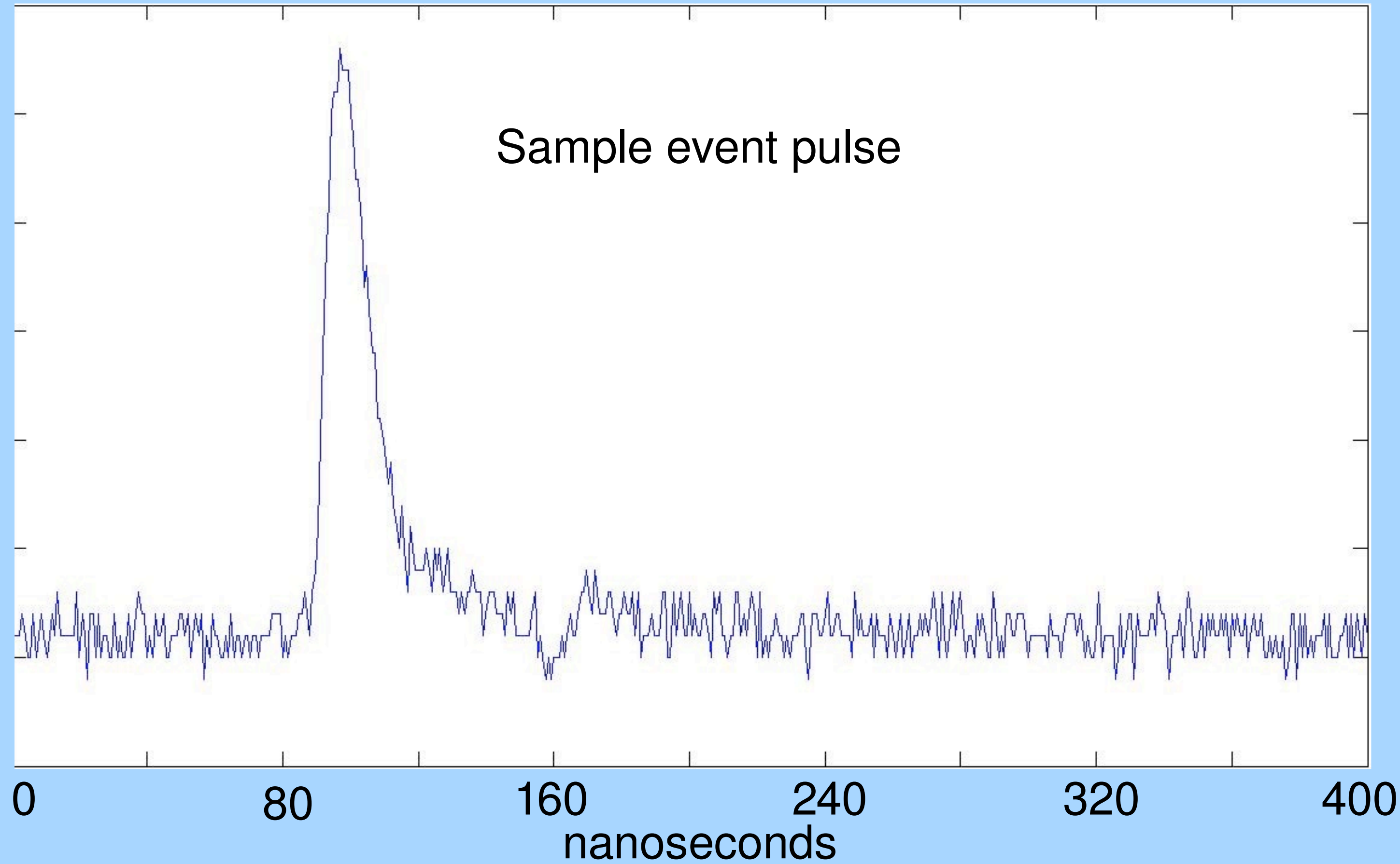


My Detector

The detector is a 2 in. x 2in. liquid scintillator hooked up to a PMT.

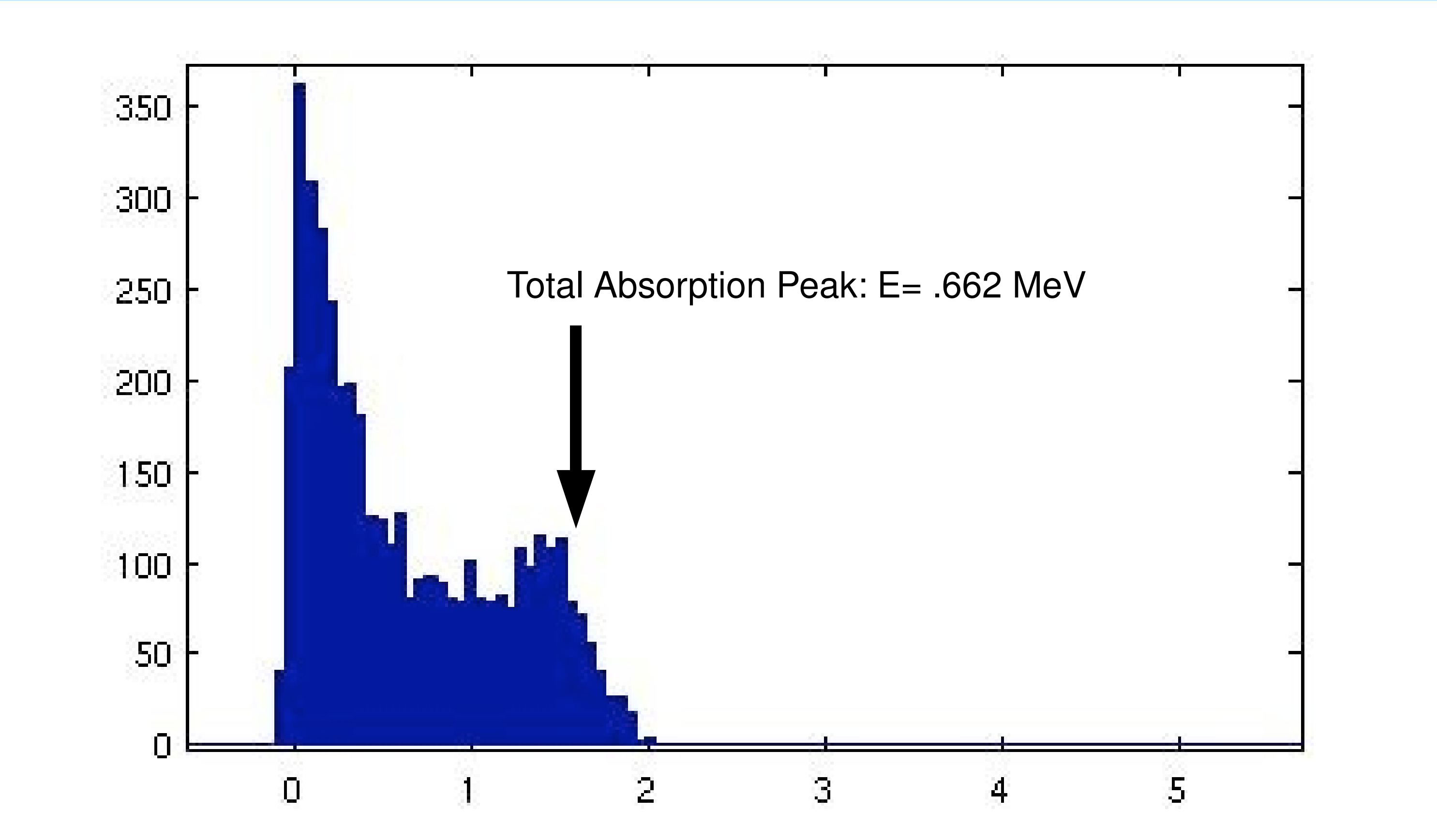
Data was read via a digital oscilloscope.

The goal of this detector was to study background radiation in the MINOS tunnel, specifically beam coincident neutrons.



Gamma Energy Calibration

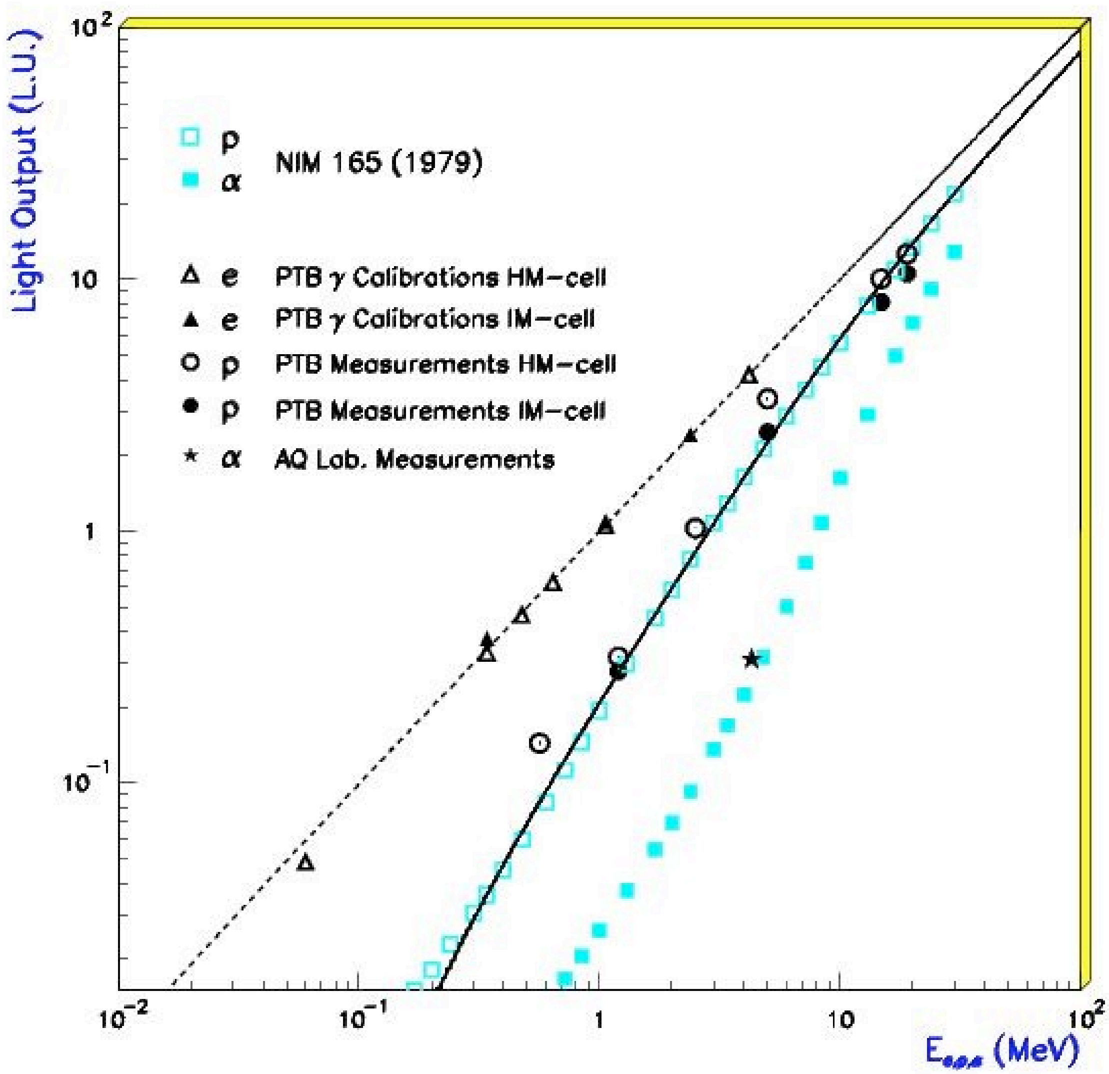
Histogram of energy from Cs-137 source in arbitrary units



Integral of Pulse Data (Arbitrary units)

Neutron Energy Calibration

Light output data for protons, electrons, and alphas.

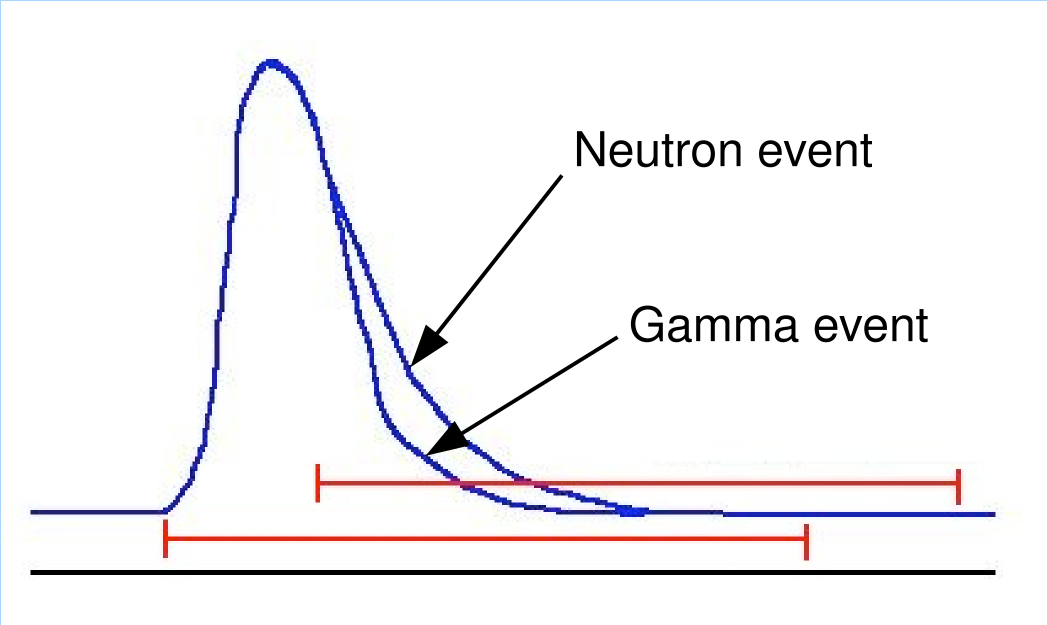


ICARUS Collaboration, “Calibration of BC501A Liquid Scintillator cells with monochromatic neutron beams.” 13 March 1998

Arb. Units	Neutron Energy MeV
1	1.7
5	5.0
10	8.2
50	30
100	58

N=.56*A+1.9

Gamma/Neutron Separation



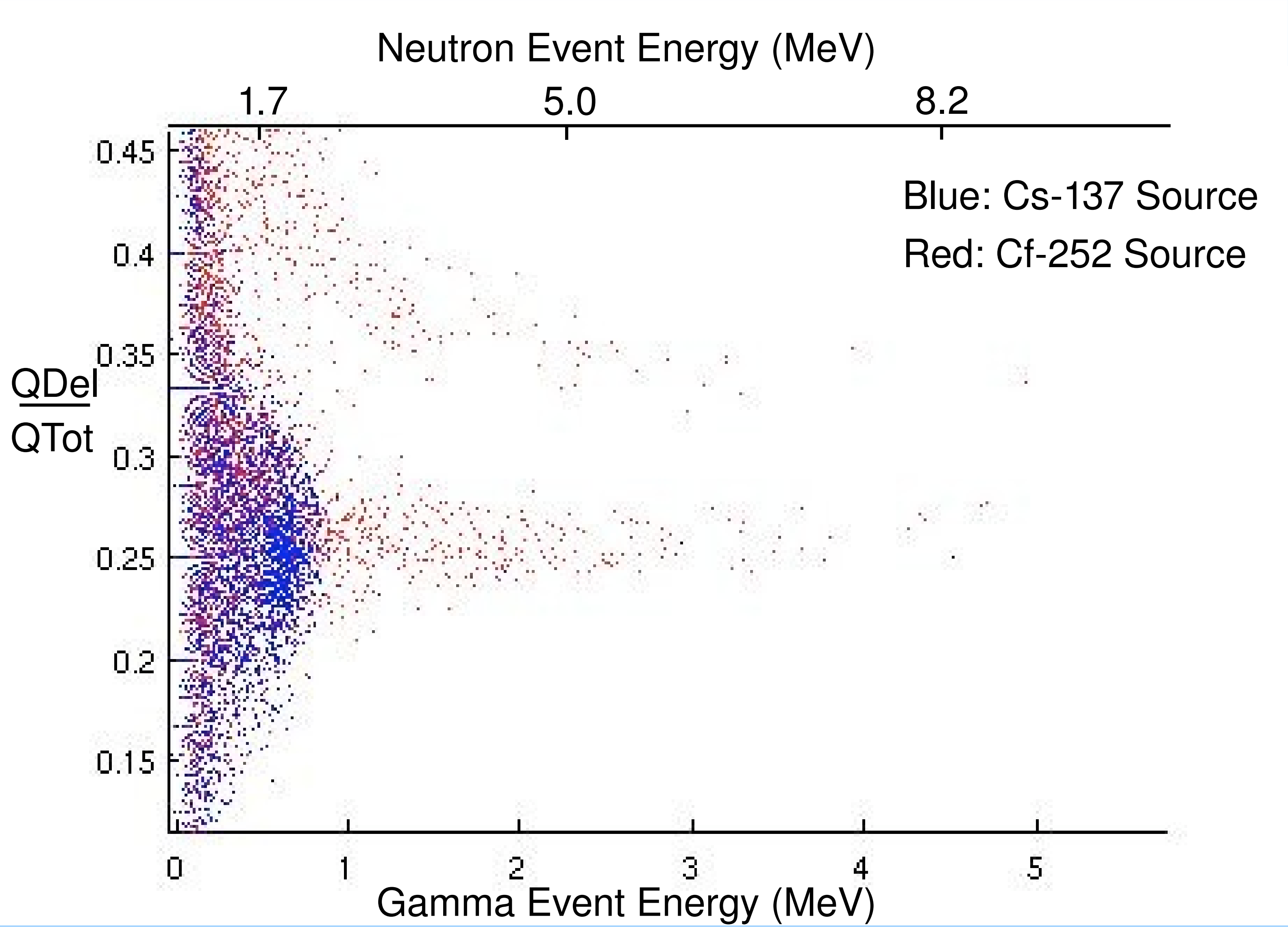
Algorithm: Tail to Total Ratio

Qtot=Integral of 130 bins from beginning of peak

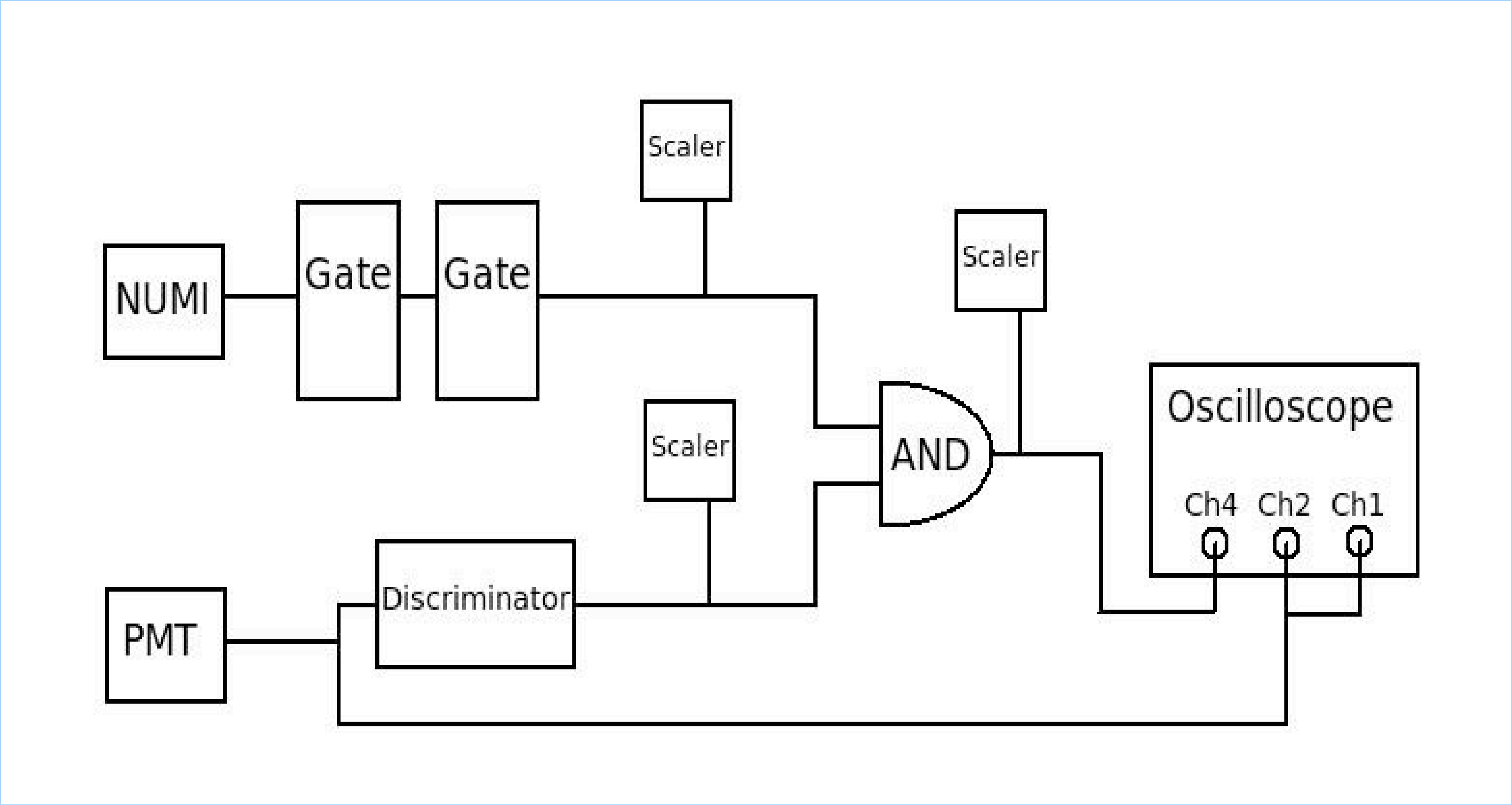
Qdel=Integral of 130 bins starting 30 bins after beginning of peak

The variable used for separation is Qdel/Qtot

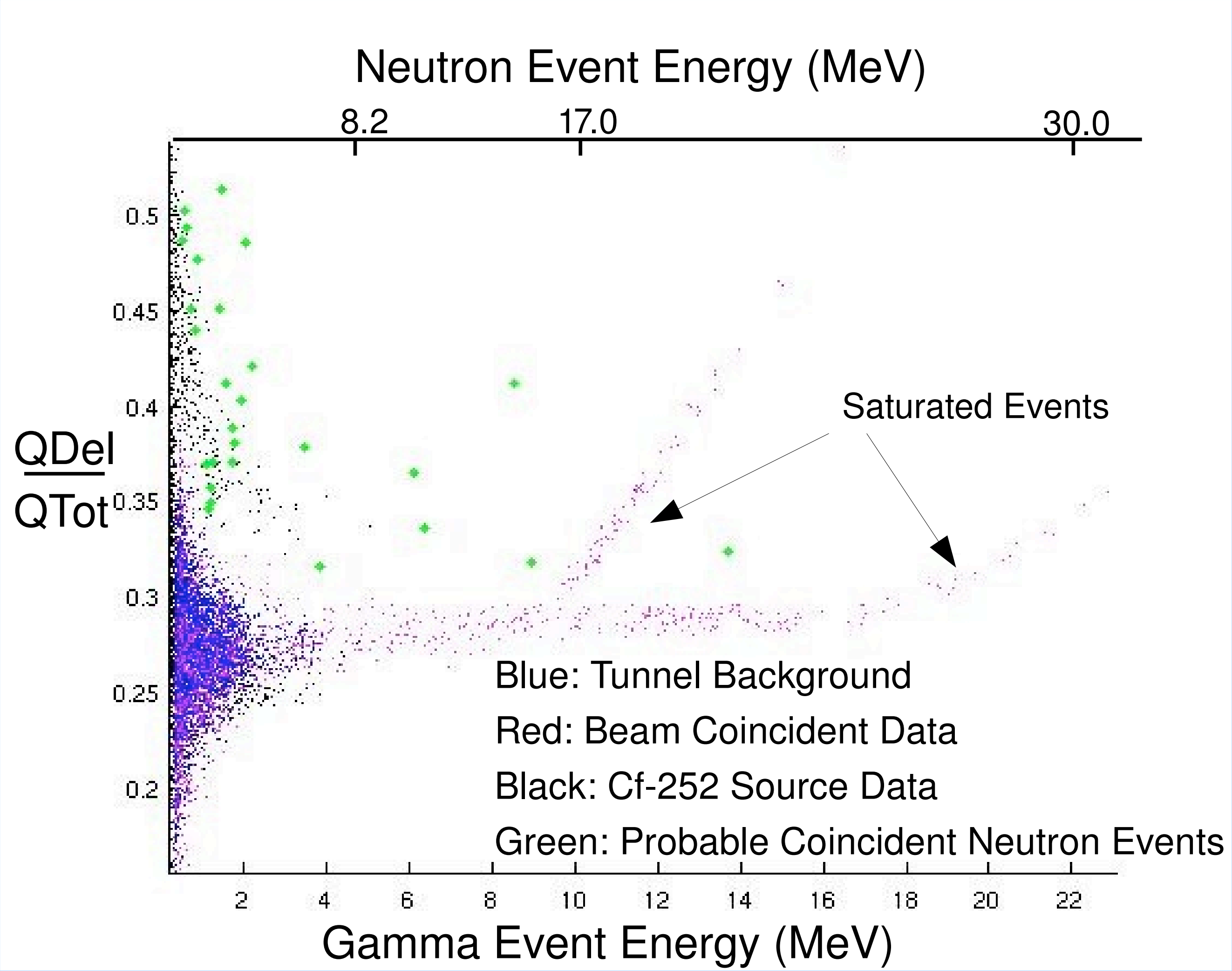
Gamma/Neutron Separation



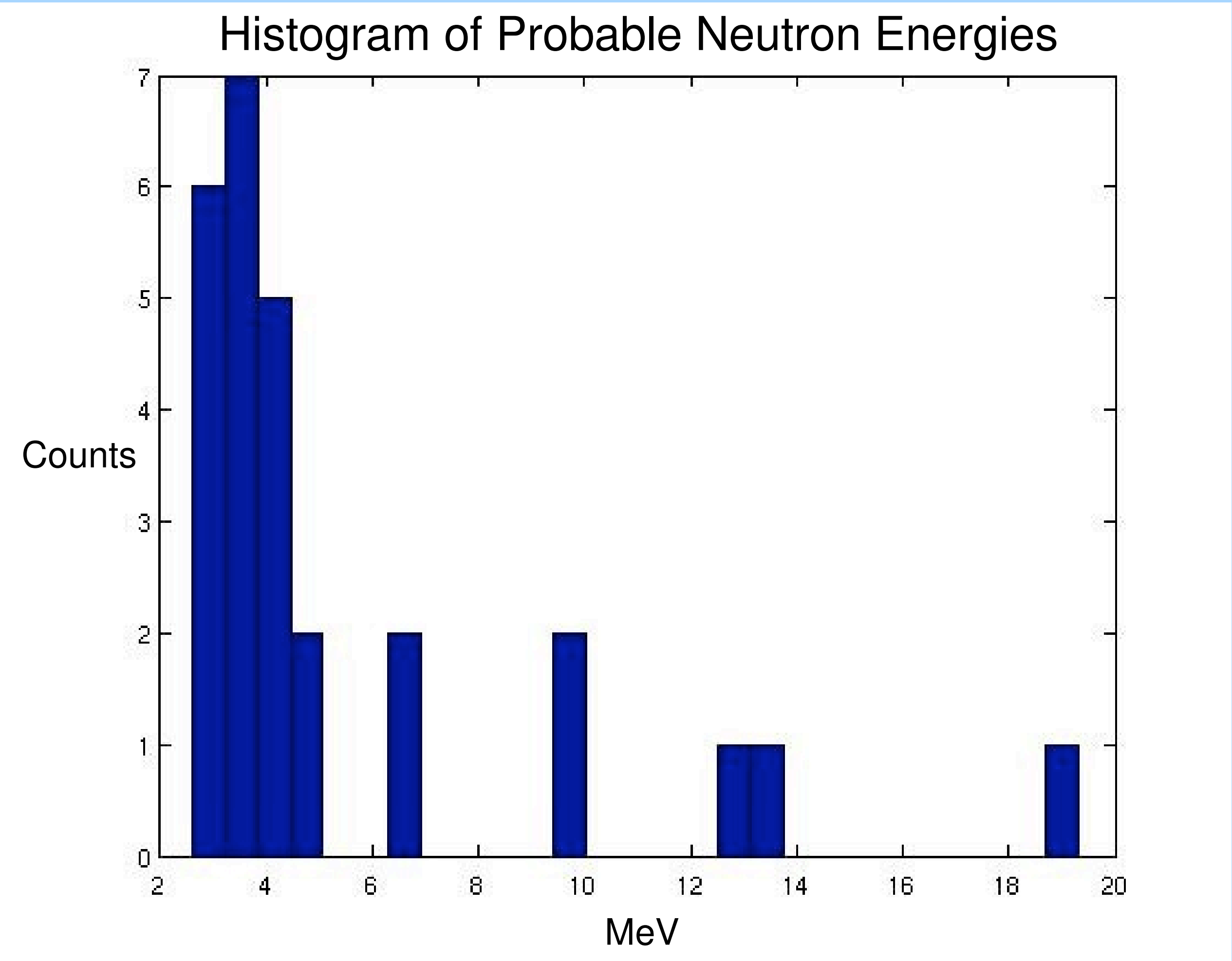
Tunnel Setup



Data


Neutron Event Energy (MeV)
8.2
17.0
30.0
QDel
QTot
0.5
0.45
0.4
0.35
0.3
0.25
0.2
Saturated Events
Blue: Tunnel Background
Red: Beam Coincident Data
Black: Cf-252 Source Data
Green: Probable Coincident Neutron Events
2
4
6
8
10
12
14
16
18
20
22
Gamma Event Energy (MeV)

Coincident Neutron Energies



27 Probable Neutrons

375,000 Beam Pulses

Highest Energy: 19.32 MeV

Future Work

Take more tunnel data:
- Attempt to develop a more accurate coincident neutron spectrum

Improve energy calibration:
- Determine if Cs-137 peak was full absorption or Compton scattering peak
- Explore other neutron calibration methods

Better separation algorithm:
- Pulse Shape Analysis, a three term exponential fit

Shielding studies
- Use this detector in conjunction with different shields to test their effectiveness

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Any Questions?